DOCUMENT RESUME

ED 316 144 HE 023 257

AUTHOR Meisner, Gerald W.; Lee, Ernest W.
TITLE Honors Workshop for Middle School Science Teachers. Final Report.
INSTITUTION American Association of State Colleges and Universities, Washington, D.C.; North Carolina Univ., Greensboro.
SPONS AGENCY National Science Foundation, Washington, D.C.
PUB DATE 26 Oct 88
GRANT TEI-8470669
NOTE 34p.; This report is one of a group gathered by the AASCU/ERIC Model Programs Inventory Project, funded by the Fund for the Improvement of Postsecondary Education to the American Association of State Colleges and Universities in collaboration with the ERIC Clearinghouse on Higher Education. For related documents see HE 023 199-261.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Administrator Education; Degree Requirements; Demonstration Programs; Elementary Secondary Education; Equipment; Higher Education; Inservice Teacher Education; Leadership Qualities; *Measurement Techniques; Middle Schools; Models; National Surveys; Preservice Teacher Education; Principals; Program Descriptions; *Science Teachers; *Scientific Principles; Sex Differences; State Universities; Summer Programs; *Teacher Qualifications; Weekend Programs
IDENTIFIERS *AASCU ERIC Model Programs Inventory Project; Honors Workshop for Middle School Science Teachers; *University of North Carolina Greensboro

ABSTRACT

The Honors Workshop for Middle School Science Teachers was designed to address teachers' conceptual understanding of basic scientific principles, student misconceptions and how to deal with them, and observation and measurement techniques. For 4 weeks in summer and on 6 Saturdays during 2 academic years, 30 leaders among science teachers from the area worked in a laboratory setting on areas identified by participants in the planning process, including basic measurements and associated errors, simple circuits, optical properties of lenses, importance and use of diffraction gratings, basic chemical experiments, and basic geology of the region. It was found that the level of teacher preparation was poor, and participants lacked basic knowledge of observations and measurements. A positive attitude toward physics and favorable administrative policy toward science are seen to be as essential as mastery of subject matter. It is recommended that: (1) there be a substantial increase in equipment for basic measurements; (2) middle school principals should have a better and different science background; (3) the state should require a year of conceptual physics for middle school teachers; and (4) a survey of teachers in different parts of the country should be undertaken to examine possible differences between male and female science teachers. Twenty statistical figures are appended. (MSE)

ED316144

FINAL REPORT

Grant No. TEI-8470669

Honors Workshop For Middle School Science Teachers

Gerald W. Meisner, Dept. of Physics
Ernest W. Lee, School of Education

University of North Carolina at Greensboro
Greensboro, NC 27412-5001

HE023257

AASCU/ERIC Model Programs Inventory Project

The AASCU/ERIC Model Programs Inventory is a two-year project seeking to establish and test a model system for collecting and disseminating information on model programs at AASCU-member institutions--375 of the public four-year colleges and universities in the United States.

The four objectives of the project are:

- To increase the information on model programs available to all institutions through the ERIC system
- To encourage the use of the ERIC system by AASCU institutions
- To improve AASCU's ability to know about, and share information on, activities at member institutions, and
- To test a model for collaboration with ERIC that other national organizations might adopt.

The AASCU/ERIC Model Programs Inventory Project is funded with a grant from the Fund for the Improvement of Postsecondary Education to the American Association of State Colleges and Universities, in collaboration with the ERIC Clearinghouse on Higher Education at The George Washington University.

Honors Workshop for Middle School Science Teachers Final Report

MIDDLE SCHOOL SCIENCE TEACHING

Report of NSF Grant No. TEI 8470669
Gerald W. Meisner, Department of Physics and Astronomy
Ernest W. Lee, School of Education
University of North Carolina at Greensboro
Greensboro, NC 27412-5001

INTRODUCTION

Ernest Lee, School of Education, and Gerald W. Meisner, Department of Physics and Astronomy, University of North Carolina at Greensboro, have been working with 30 highly selected middle school science teachers for the past two years.

These teachers, showing significant leadership roles, were chosen from the populous Piedmont region of North Carolina, are mostly female, and are equally distributed among urban schools and those in more rural counties. For 4 weeks during each summer we met from 9 AM to 4 PM, on several nights from 9 until 11, and for three weekend geology field trips to the coast and to the mountains. On six Saturday mornings during the academic years we discussed implementation of summer work, edited demonstration and laboratory material, evaluated material pertinent to middle school science, and planned future work with the middle school science teachers in school systems represented by the 30 participants.

We have focused our efforts on middle school science teachers for several reasons:

1. Instead of science subjects being taught individually in the middle school grades, beginning in 1985 earth, physical and life science were to be integrated in all grades. Data from science supervisors in school systems in surrounding counties indicated that between 50 and 80% of those scheduled to teach these subjects were inadequately prepared.

2. 60% of the student science enrollment exits in the middle school grades, yet only 51% of the teachers who taught science in these grades were appropriately certified to teach in their area (NC, 1982-3). In contrast, 85% of those teachers who taught science in grades 10-12 were appropriately certified.

3. Whereas 50% of science teachers in the nation for grades 7-12 hold masters degrees or higher, this figure is only 22% in North Carolina for middle school science teachers.

PURPOSE

Our purpose for conducting the workshop was to deal with:

1. teacher conceptual understanding of basic scientific principles.
2. student misconceptions and how to deal with them.
3. the development of tests suitable for evaluating student understanding of fundamental concepts.

In spite of working with the best and the brightest, the goals were too comprehensive to be met in a two year period. We can report substantial progress on (1.) above, a moderate amount of progress on (2.), a start on object (3) and significant progress on (4), which is a foundation stone we erroneously took for granted, namely:

4. working knowledge of the basic scientific method, which has at its soul the acts of observation and measurement.

It was by working with this last goal that we have achieved the most success and which we feel is the linchpin for a successful middle school science program. A spin-off of this success was the greatly increased confidence in working with basic and simple equipment which most of the teachers rapidly acquired. We cannot stress too strongly that the lack of adequate numbers of basic measuring devices such as meter sticks, thermometers and balances clearly must be addressed before other shortcomings in science teaching in middle schools can be addressed. We have learned that all too often a science department purchases a single expensive piece of equipment rather than many inexpensive although critically needed smaller devices.

WHAT THE TEACHERS GAINED

The teachers put in a great deal of time, but were compensated with 10 graduate credit hours in physics and science education toward a masters degree, stipend for their time during the summer and the academic year, and a quantum increase in the confidence in being able to identify, understand and teach basic concepts in physical science and earth science. As a spin-off, they are much more comfortable about data collection and measurement in aspects of life science as well.

As is often the case with environments in which many people work very hard, close personal and professional friendships develop. They now know each others strengths and call on each other for help in areas where they need improvement. They have numerous demonstrations which they made and have used successfully in their classrooms. Several source books which they now have [Modern Astronomy by Robbins and Heminway, String and Sticky Tape Experiments by R.D. Edge, North Carolina Marine Education Manual by L. Mauldin and D. Frankenberg, North Carolina Geology & Mineral Resources by W. F. Wilson et al., others] are heavily used. In addition, they wrote, compiled and edited a large collection of demonstrations and laboratories suitable for the middle school science teachers which will be reviewed and edited for initial distribution throughout central region of North Carolina. Finally, two of the teachers presented a paper at the annual North Carolina Science Teachers Association meeting in 1986, four presented additional papers in 1987, and four others traveled to St. Louis for the annual National Science Teachers Association meeting in 1988 to present results of interest to middle school science teachers. Needless to say, the spin-off effect on local school boards and administrations is considerable, and the heightened awareness mandated by the sharing (with the NSF grant) of the expenses of the trip by the school systems sharpens the focus on science.

Many teachers state that they now approach nearly all aspects of science in the middle school from a hands-on approach. ..."My students have developed such a positive attitude and have turned into 'little scientists'"..."One thing I'm proud of is that they have learned to never depend on one measurement"...."students have benefited indirectly through curiosity" ...are representative of comments written by the participants in response to an open-ended question regarding the extent to which aspects of the workshop are transferable to the classroom.

Most importantly, the workshop participants were invigorated with new content and ways to teach science. We are working with several of the participants in trying to quantify these qualities which are so difficult to measure by using and/or developing tests which examine basic conceptual understanding and science attitudes.

WHAT THE TEACHERS ARE GIVING

In addition to a good deal of time spent in the workshop and in commuting (one teacher lived in Virginia), the extra time spent making observations and measurements at night, on weekend field trips, and on Saturday morning meetings was considerable. One third of the teachers are working with us in several spin-off research projects and are editing the demonstration manual. All are required to give several workshops on some subject matter covered by the workshop and the associated lab and/or demonstration to colleagues in their school system.

WHAT WAS LEARNED?

1. PREPARATION: 27 of the 30 teachers felt much better prepared in biology than in physical science, 3 felt adequate in chemistry, and none felt adequately prepared in physics and/or astronomy.

2. EXPERIMENTATION: Nearly all of the participants were in desperate need of learning the importance of individual observation, measurement and experimentation on a <u>very fundamental</u> level. This cannot be stressed too strongly.

3. BASIC CONCEPTS: A test administered to the participants of basic astronomical concepts, a model of the solar system, properties of lenses and mirrors, rock formation and several other basic ideas in physical and earth science revealed a vast ignorance, which they were very willing to correct.

4. TIME SCALE: We have determined that even the best of middle school science teachers have so much to learn that at <u>least</u> two years and preferable more is necessary to accomplish the goal of retrofitting the participants with content and the correct approach to science teaching. The ramification for programs/workshops dealing with too much, too fast is evident. Short expensive workshops, no matter how well performed, are simply not cost/learning effective.

5. LABORATORY SKILLS: We have developed a framework whereby teachers are developing measurements/observations for students in their classes to introduce them to the necessity and value of accurate and repeated measurements, to determine how students approach such activities, and to look for correlations among demonstrated abilities and class level, sex, economic status, and environmental background and formative experiences.

6. ATTITUDES: Slightly more than one-half of the teacher participants immediately responded positively to the immersion in measurements, observations and experimentation. All but one did so by the end of the first four summer weeks. A survey of their attitudes indicated that there was no difference between male and female initial favorable reaction to the emphasis on hands-on activities and measurements, but that four of the five strongly negative initial reactions were female. We are in the process of gathering statistics on this and related attitudes among science teachers on a state wide basis. Interviews suggest a lack of exposure and experience as the reason for initial reticence to actively explore phenomena. Because of this, some of these teachers and many of their colleagues routinely skip certain topics of physical science, particularly physics. The implications for teacher preparation curricula is obvious.

7. INSTITUTIONAL ROADBLOCKS: Although there is some small variation, principals at middle schools generally wield considerable influence over the direction the school moves and on the general atmosphere in the school. We find that in spite of good intentions, a large fraction of the participants are unable to effectively reach their goals as science teachers because of institutional obstacles. Inadequate funding for basic and necessary scientific equipment (with principals insisting instead for a single piece which is 'showy' and expensive), a lack of empathy for the unique needs of a successful science program (rooms which look different and have students talking to each other as they explore and experiment), and a lack of support for the need for professional development (attending seminars and meetings) are problems which many teachers contend with. We are in the process of gathering state-wide data on the background of principals and their attitude towards science.

WHAT DID $150K BUY FOR THE PIEDMONT REGION, NC?

It is a simple matter to delineate the benefits to the 30 participant teachers, as has been done above. If they were the only disciples of our efforts to improve science education, this program would not have been cost-effective.

We have a procedure incorporated into the workshop to multiply the benefits, and a second method has been developed, partially at the suggestion of some of the teachers:

1. ADDITIONAL WORKSHOPS: All teachers are required to present at least two workshops to colleagues in their school system, covering material worked on during the summers and tested and written up during the academic year. Nearly all have already done so; the rest will complete this assignment this fall. 10 +/- 2 colleagues each workshop.

2. COMPUTER NETWORK: A teleconferencing system (NEWTON) is being implemented on the university's VAX system. This system will permit daily contact among these teachers, colleagues in their own and in nearby school

systems, and scientists and educators at UNCG. Some of the information which will be exchanged include ideas for demos, labs, science fairs, equipment sources, tips on how to approach a certain topic, test questions, professional meetings, etc. Two teachers are to have responsibilities in each of the areas of physics, earth science, chemistry and biology. One will be content coordinator and one will be moderator. Meisner and Lee will be sysops and will have the help of graduate students in both the physical sciences and in science education. There is sufficient interest to carry us through at least two years, after which we believe there will be enough others interested in this aspect of science education to make the system self-sustaining.

3. PROFESSIONAL RECOGNITION: We have persuaded Sigma Xi, the Scientific Research Society of North America, to take an active interest in the teaching of science in the elementary and secondary school systems. We also were successful in getting our Representative in Congress to come to one of the workshop meetings, see what was happening, and give words of appreciation for the work the participants were doing. An increase in public visibility is essential to the well-being of the teaching of science.

EXPORTABLE BEYOND THE PALE

Essentially everything covered in the workshop was exportable to the classroom of the middle school science teacher. This is certainly not surprising since teachers were intimately connected with the planning and operation of the workshop. What about elsewhere?

1. The school system: As explained above, the benefits of the workshop will extend to all corners of the school system because:

a. all teachers are conducting workshops, as stipulated in the 'contract' agreed to when the participant came 'on board' for the two year period.

b. principals of the teachers agreed to facilitate the conducting of the workshops as a condition that their teacher be chosen for the program.

c. the teachers were chosen as much for their leadership ability as for their teaching expertise.

2. North Carolina's North Central Education District: NEWTON, the teleconferencing and data base system described above, can be used by any teacher with access to a Apple or IBM-type microcomputer and modem. All high schools and some middle schools currently have modems in some school systems. By the end of this academic year, nearly all should. Through the use of a statewide system LINKNET, dialing up UNCG's Academic Computing Center will cost most teachers only a local phone call.

3. Statewide: With backgrounds in science education and physics, the PIs hope to work successfully with the State Department of Public Instruction to change the type of required science courses for undergraduate education majors. An

encyclopedic survey of science facts is not what these science teachers need. It is far better for them to dig deeply into fewer topics in a laboratory oriented way than to be exposed to a smorgasbord of details with no firm conceptual understanding of basic principles.

WHERE ARE WE GOING FROM HERE?

We are implementing five projects which are a direct growth of this workshop:

1. Demonstration/lab Manual: for middle school science teachers, written and edited by participants, described above. A first edition copy is enclosed as a part of this Final Report. There are separate sections for sixth, seventh and eighth grades. A streamlined second edition will be reproduced and distributed at the expense of the local school systems.

2. Video Tape: made during the workshop by the university and by teachers of their classes doing experiments with equipment made/used in the workshop. There will be two versions - one fifteen minutes, showing apparatus, children using the equipment, teachers learning how to use it; the other a five minute abridged version for workshops, meetings. Severe editing work to be done on both. Enclosed is a copy of the short version of the video tape, showing activities during the workshop as well as in the classroom which are directly attributable to the workshop. In addition, there is a small amount of footage of Dr. Paul Taylor, Director, Division of Science and Congressman Howard Coble, Representative from the 6th Congressional District taken while they were here observing and taking part in the workshop.

3. NEWTON: teleconferencing system described above.

4. Statistical Analysis of Background of Middle School Science Teachers: We are examining their college preparation, availability of equipment in the classroom, time allocated to various sciences, and affect of exposure to their environment to ways of teaching science. We have randomly selected one-third of the middle schools in North Carolina and have distributed detailed questionnaires to all of the science teachers in those schools. More than half have returned the questionnaire, giving us a sample of 558 teachers, two-thirds of whom are female. Complete results will appear in a forthcoming article to be submitted to the Journal of College Science Teaching.

Summary of Findings

a. Figures 1 and 2 show that while the number of middle school female science teachers who have taken one or more biology courses is about 95%, the number of females who have taken one or more physics courses is about 67%, and, sad to say, the number who have taken one or more astronomy courses is much less. Corresponding numbers for males is slightly better. The data for astronomy courses is especially disturbing since astronomy receives much popular press and is therefore of great interest to children. Most importantly, it is a fine paradigm of science and the scientific method. Figure 3 shows the relative preparation of males and females in the various sciences. Adequate preparation in astronomy is nearly non existent, and reasonable preparation in biology is far more prevalent than in the physical sciences.

b. Anecdotal testimony in the Honors Workshop indicated that many teachers exhibit such a high degree of anxiety towards physics that they give it short shrift in the teaching of an integrated science curriculum. Although there is some ambiguity in Figure 6, the essence is clear - on the order of 50% more time is spent on teaching biology than on teaching either of the major physical sciences. Figure 4 gives a comparison between biology and physics in another aspect, wherein respondents were asked to rank the degree of anxiety they felt towards teaching these two subjects. Anxiety is a product of the lack of preparation and results in a lesser quantity and quality of physics presented in the classroom. There is a closed loop of negative feedback; it is our opinion that *institutional* changes in the courses required of school teachers must occur before substantial changes occur in the science preparation of school children. One of those needed changes is indicated by Figure 5, which shows that about 40% of the responding middle school science teachers took their last physics course at least 12 years ago.

c. The lack of preparation and ensuing uncertainty about their ability to effectively teach physics leads to an over-reliance on 'book learning', memorization of facts and a underutilization of demonstrations and laboratory work as vehicles of understanding and a building of an intuitive sense of the world. Figures 7 and 8 summarize our findings in these areas. There is, furthermore, a concomitant dearth of basic lab equipment, which is *only partly due to lack of funds*. At least, and in our opinion, of more importance is the lack of confidence of handling the subject matter and the lack of exposure to handling and using equipment of the most rudimentary kind. A summary of the numbers of meter sticks, beam balances, batteries and bulbs and other items is shown Figures 10 and 11. These are cumulative graphs. For example, Figure 10 shows that over 20% of the teachers have 0,1 or 2 meter sticks at their disposal, and Figure 11 shows that over 40% have the same small number of batteries and bulbs to use. Figure 11 illustrates another institutional problem - middle school science teachers do not get the proper amount of time to set up demonstrations and labs. Nearly 45% of the respondents are allocated less than 30 minutes per day to set up all of their science equipment. Even the knowledgeable teacher with adequate equipment would find it extremely difficult to adequately do 'hands-on' teaching in that environment.

d. We questioned the background of those responding to the questionnaire, and find that those teachers who had a rich mechanical background (made things with their hands as kids, tinkered with cars, etc.) were nearly twice as likely to stress observations as were those who did not have a rich mechanical background.

e. Females are nearly twice as likely to stress observations in their classroom as are their male counterparts, whereas males are 60% more likely to stress factual knowledge than are their female colleagues. The ramification for the screening procedures for aspiring teachers is obvious.

5. Statistical Analysis of Background of Middle School Principals: We have examined the college and school system background as well as attitudes toward science teaching in middle schools of nearly 300 randomly selected principals of middle schools in North Carolina. Complete results will be presented to the administrative division of the Department of Public Instruction of North Carolina. If the findings warrant more publicity, we will work with the state to provide it.

Summary of Findings

a. Figures 12 and 13 show that 5% of the middle school principals majored in one of the physical sciences (none majored in physics), whereas roughly one-half the females and one-quarter of the males majored in education. Males were three times as likely to have.majored in physical education or any of the life sciences, and five times as likely to have majored in social science. With the exception of education, female middle school principals had a fairly even background of majors.

b. Figures 14 and 15 show that middle school principals have had only a very limited exposure to physics and astronomy as undergraduates. Whereas nearly 90% (60) have had at least one (two) biology course(s), the figures for physics is 40% and 25% respectively. Astronomy fares far worse, with only 15% of the responding middle school principals having had at least one course in that discipline.

c. Figure 16 reveals that roughly 20% of the middle school principals have taught science for at least four years since they entered the public school system. Figures 17 and 18 show that most of the middle school principals have not had any recent exposure to science of any type. Since they did not have much background to begin with, the fact that they have not been exposed lately to any science is disheartening. Recent studies indicate what instructors in science at colleges and universities are very aware of: that the majority of public school students in the United States are poorly prepared in science. Principals of schools can have a good deal of influence over the academic program in his/her school. An academic background for principals which places far more emphasis on science, particularly the physical sciences is sorely needed.

d. Agressively training or retraining principals in addition to teachers in the fundamentals of science and how it differs from other more introspective disciplines must be done if we are to address the poor showing of U.S. students in the sciences. Figures 19 and 20 illustrate that although three-quarters of the middle school principals would attend workshops dealing with science, only one-quarter of them report that they have the time to do so. Absence of time for professional development is a long standing complaint of the teaching profession; it is a complaint of school administrators as well. This is another institutional problem which should be addressed at the state and local level.

RECOMMENDATIONS

1. Increase the quantity of equipment necessary for basic measurements. University and college science instructors should work with high schools throughout the state in an effort to more wisely use equipment money to put

basic instruments and supplies in the laboratory. Costly, showy items should in general not be purchased until basic equipment needs are met. Explanations should be given to principals, administrators and school boards.

2. Middle school principals need a better and different background in science. Middle schools are the last chance to interest many students on the excitement of science. In many school systems, principals wield considerable influence in the presentation and conduct of science classes. Without their enthusiastic understanding of the importance of how the various scientific disciplines should be taught, the efforts of even the well prepared teacher may be for naught. Yet, although their are a number of programs to update teachers in the sciences, the opportunities for principals, the vast majority of whom come to their job from a non-science background, to do so is very limited. We recommend that funds be available to correct this omission. The duration and thrust of such 'workshops' will, by nature, be considerably different than those for teachers. It is critical, however, that principals 'do' science rather than merely passively 'hear' about science.

3. Departments of Public Instruction at the state level need to require one year of 'conceptual' physics for middle school science teachers. The physics classes should stress familiarization with measurements, use of simple instruments, comfort with and expertise in demonstrating concepts in the classroom, and importance of lab work for students. It is important that it not be an encyclopedic survey course, such as many first year science courses are. Deeply into a few subjects is a better way to prepare teachers than cursorily into many subjects. For those teachers already in the pipeline, the state and the university and community college systems should work together to offer a mandatory one semester course in physics and one in chemistry, to be paid for by state and local funds, and taught in the manner described above. These courses should be taken within a three year period.

4. A survey of teachers in several states in different sections of the country should be undertaken, to ascertain whether the differences between male and female middle school science teachers is maintained. If so, the screening process for applicants into the teaching cycle needs to be changed and strengthened.

Presentations at Science/Teaching Meetings from the Honors Workshop for Middle School Science Teachers

Betty Dean and Pamela Bookout, "Getting Close to Nature: Motivation Through Outdoor Studies", National Science Teachers Association 1988 National Convention, St. Louis, 9 April, 1988.

T.J. Coates, Joan Marshburn and Ernest W. Lee, "Estimating and Measuring in Middle School", National Science Teachers Association 1988 National Convention, St. Louis, 8 April, 1988.

T.J. Coates and J. Marshburn, "Get Close to Nature: Motivation Through Outdoors Studies", North Carolina Science Teachers Association, November 21, 1987.

G. W. Meisner and E. W. Lee, "Physical and Earth Sciences for Middle Schools - A Progress Report", Spring Meeting of the Southern Atlantic Coast Section of the American Association of Physics Teachers, 26 April, 1986.

E. W. Lee and G. W. Meisner, "Science Teaching in the Middle Schools", Annual Meeting of the National Science Teachers Association, Washington, 1986.

Betty Dean, "More of the Nitty-Gritty Details about Science Fairs", North Carolina Science Teachers Association, 7 November, 1986.

G. W. Meisner, "Teleconferencing: What It Can Mean for Physics Teachers", NCSTA. Fall, 1987.

G. W. Meisner, "Modern Physics at the Middle and High Schools: What's Available at Low Cost", NCSTA, Fall, 1987.

G. W. Meisner and E. W. Lee, "Middle School Science Teaching", AAPT Summer Meeting in Montana, 1987.

G. W. Meisner, "Scientific Background of Middle School Principals: Is There an Affect on Science Teaching?", AAPT, Annual Summer Meeting at Cornell, 1988.

G. W. Meisner, "Background of Middle School Science Teachers and Their Approach Toward Science Teaching", AAPT, Annual Summer Meeting at Cornell, 1988.

FEMALE MSST

Undergrad. & Graduate Courses

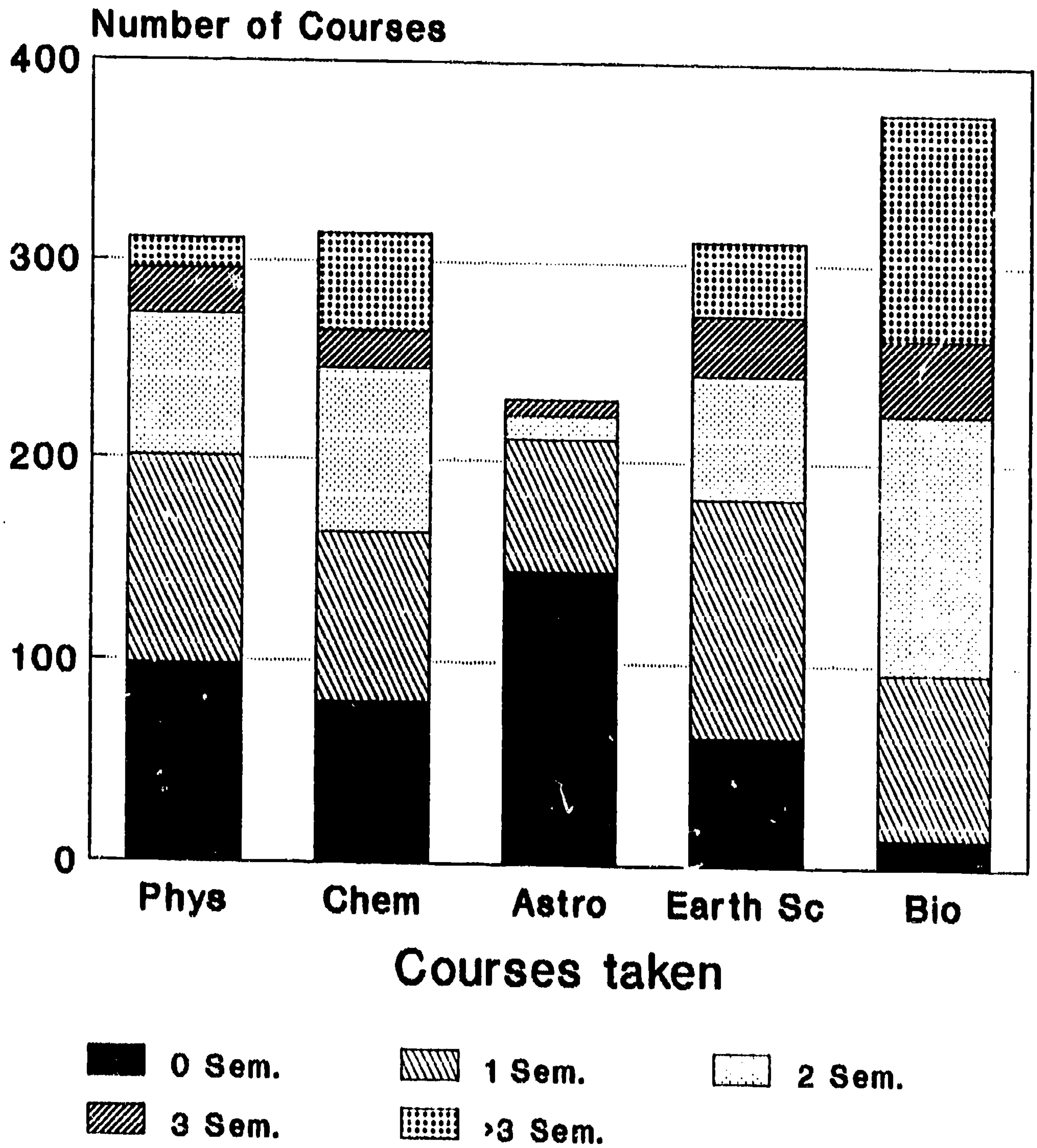


Figure 1

386 Respondents, 3 June 1988

MALE MSST
Undergrad. & Graduate Courses

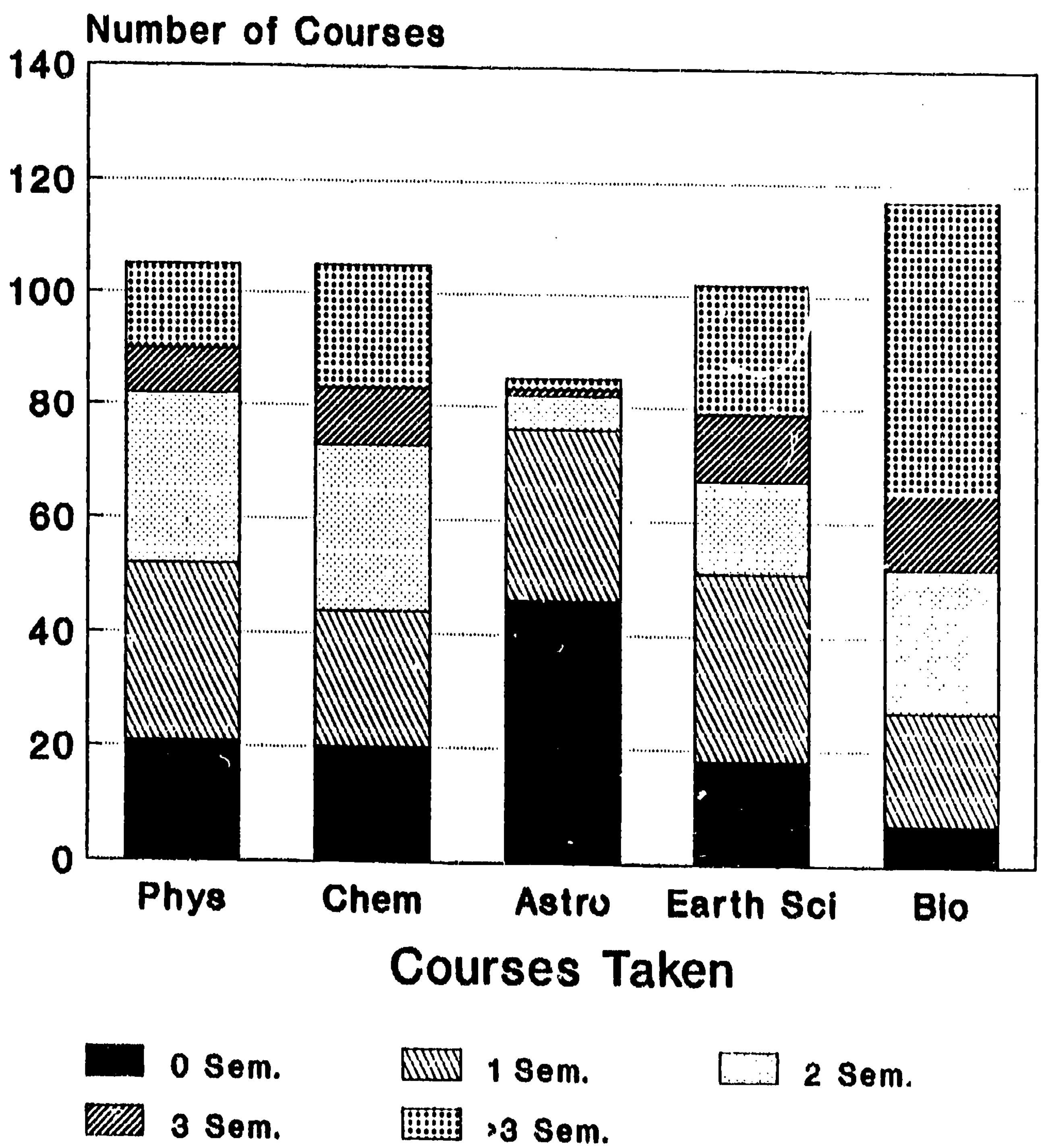


Figure 2

122 Respondents, 6 June 1988

MSST
2 or More Semesters of a Science as Undergrad

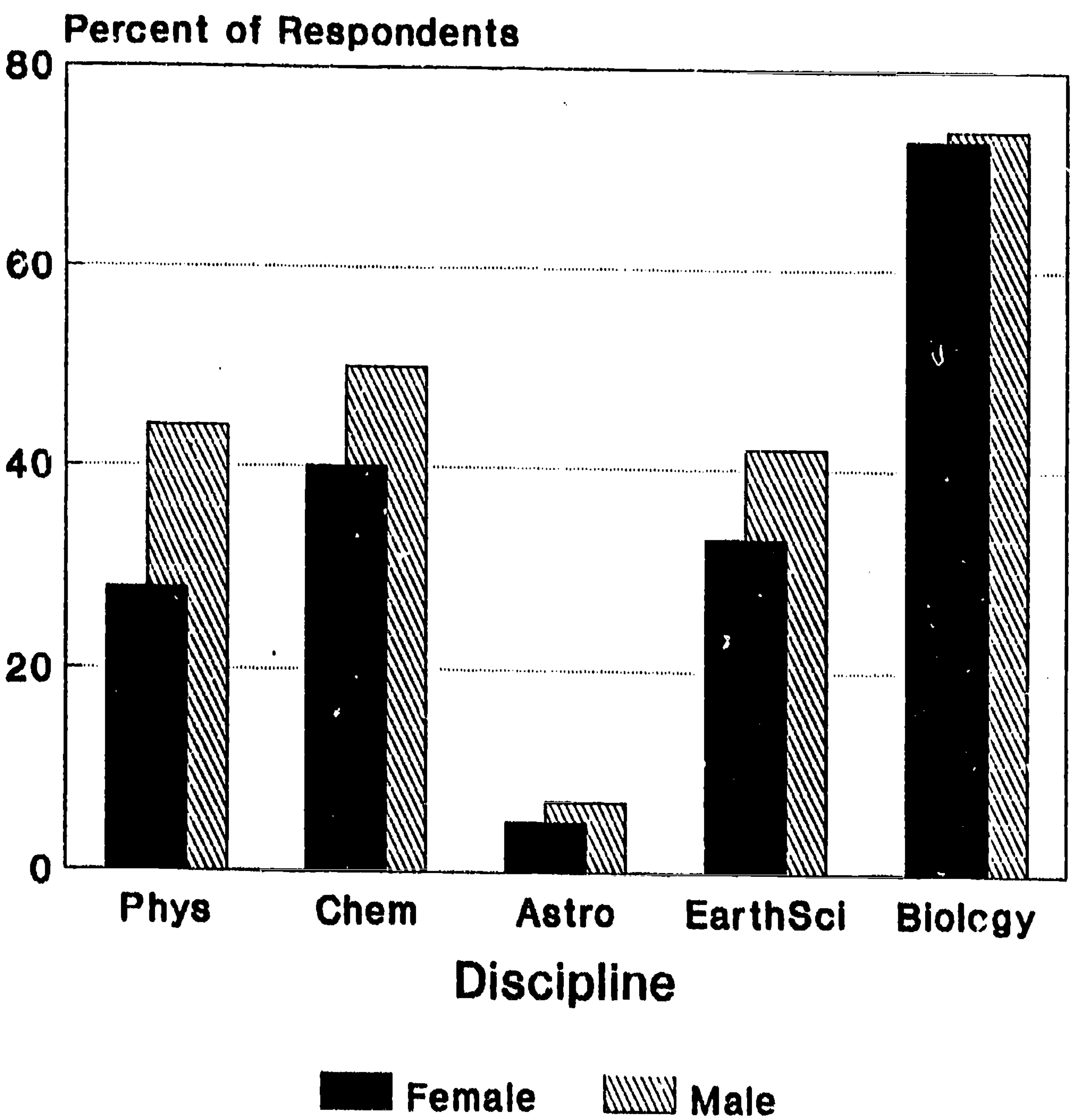


Figure 3

508 Respondents, 6 June 1988

MSST
Anxiety in Teaching: Physics & Biology

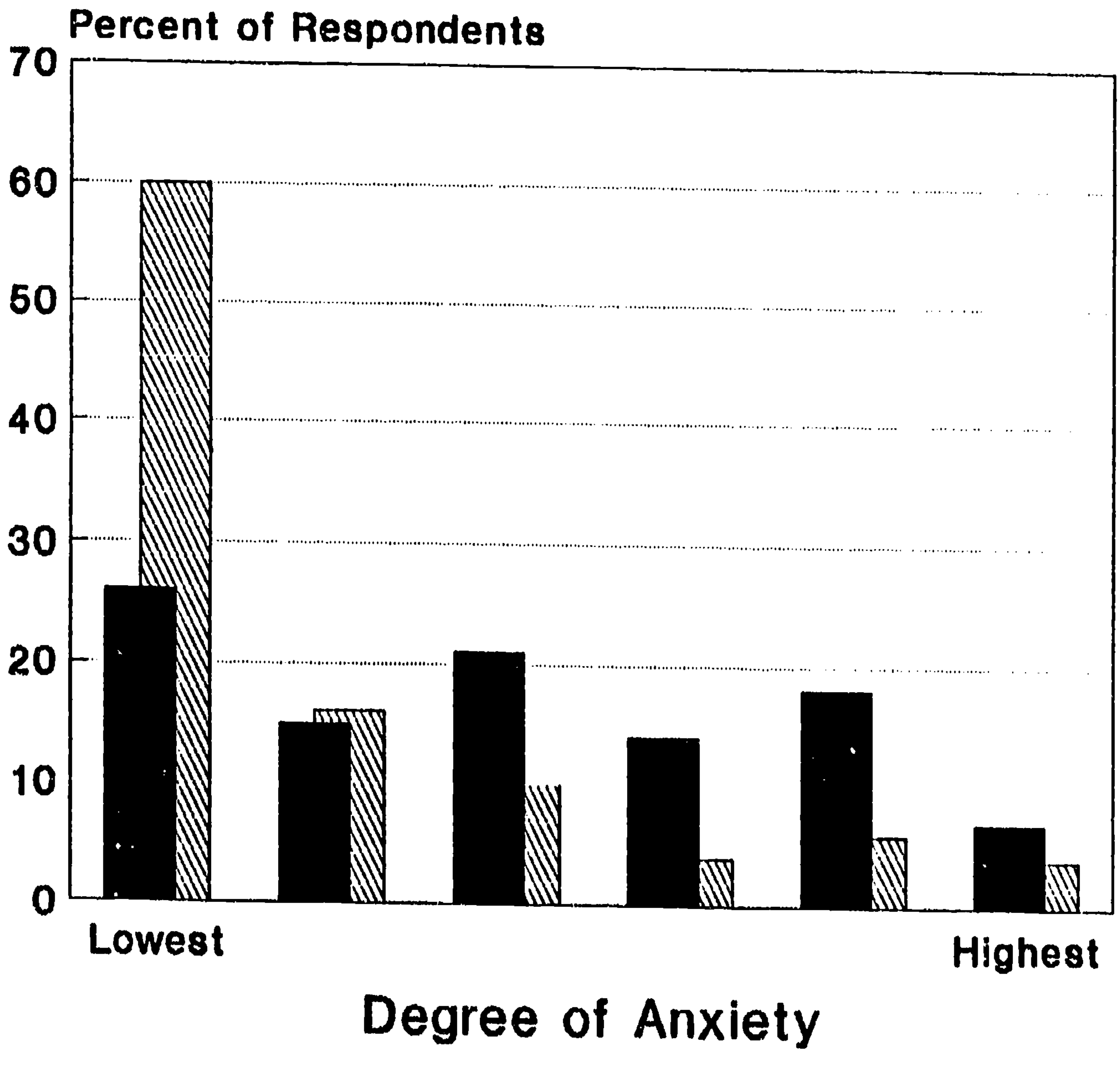


Figure 4

508 Respondents, 6 June 1988

MSST
Years Since Last Physics Class

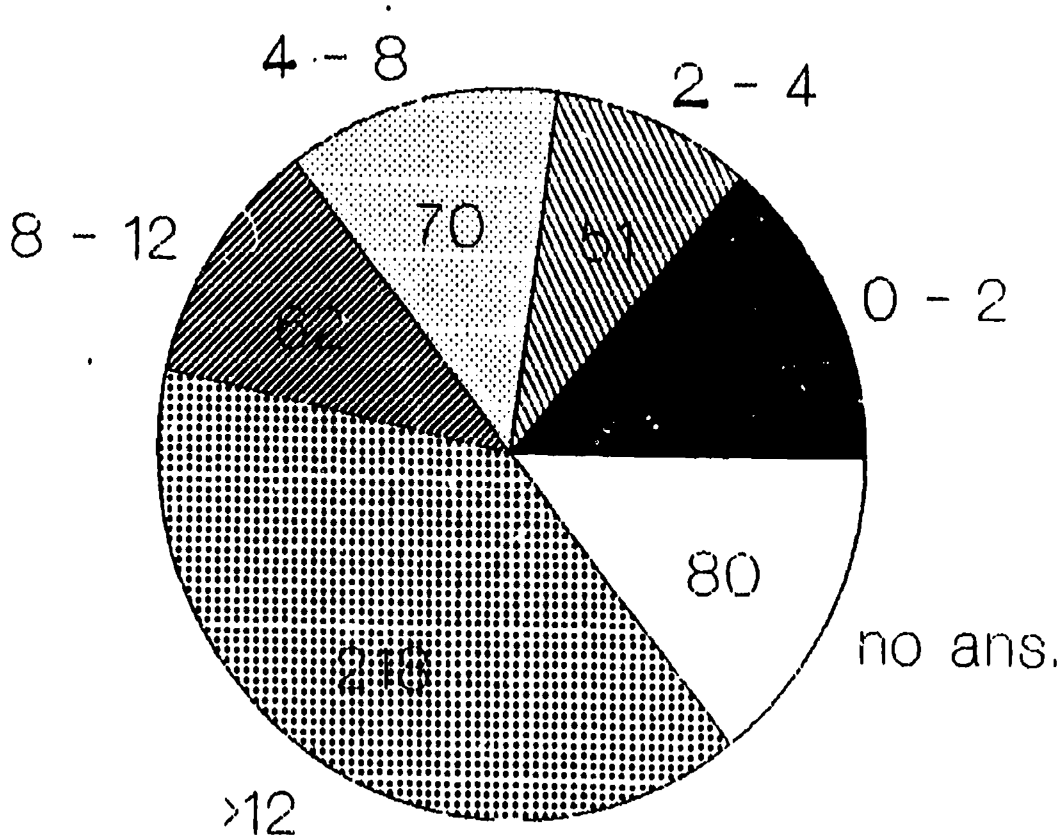
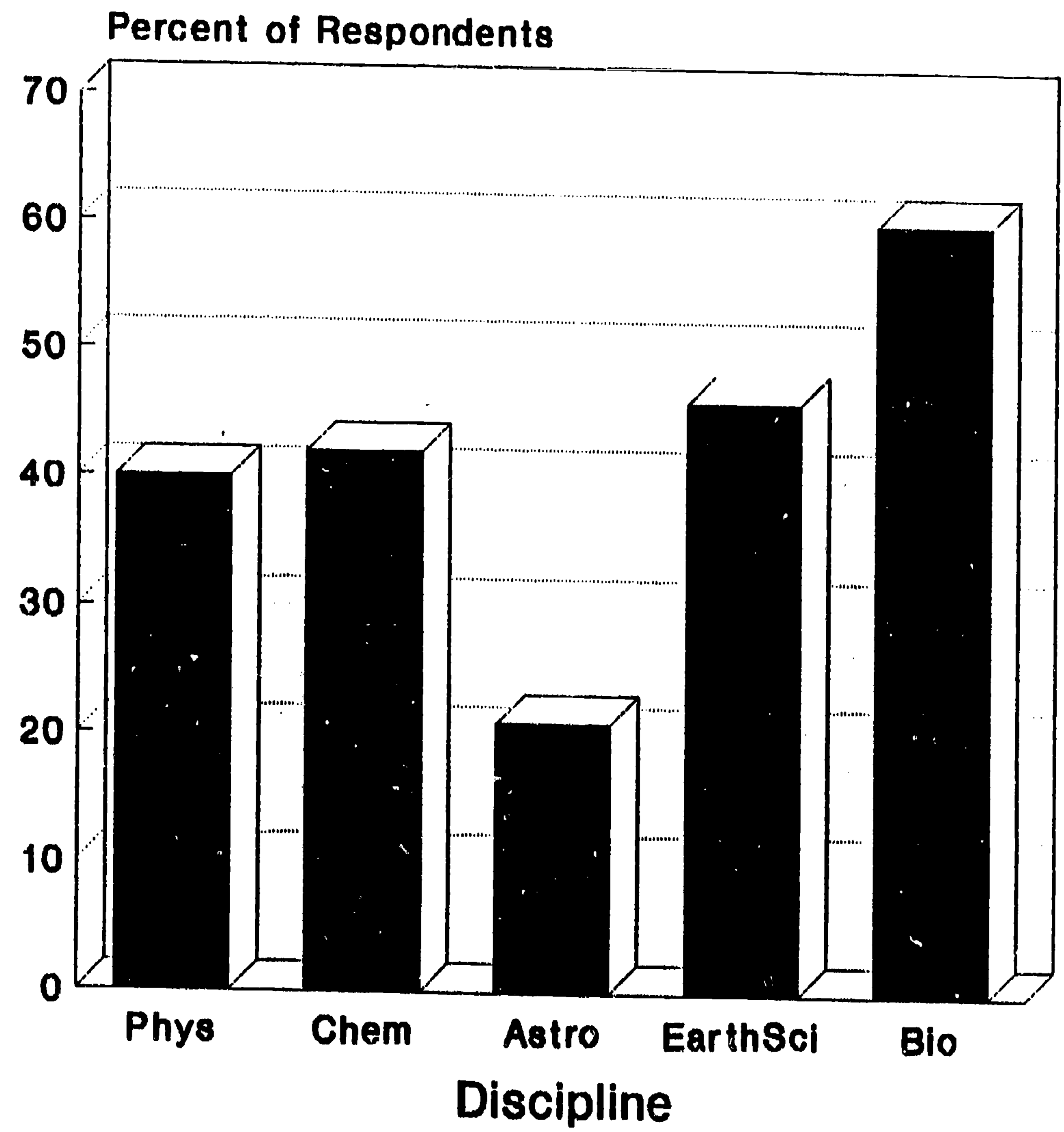


Figure 5

558 Respondents, 6 June 1988

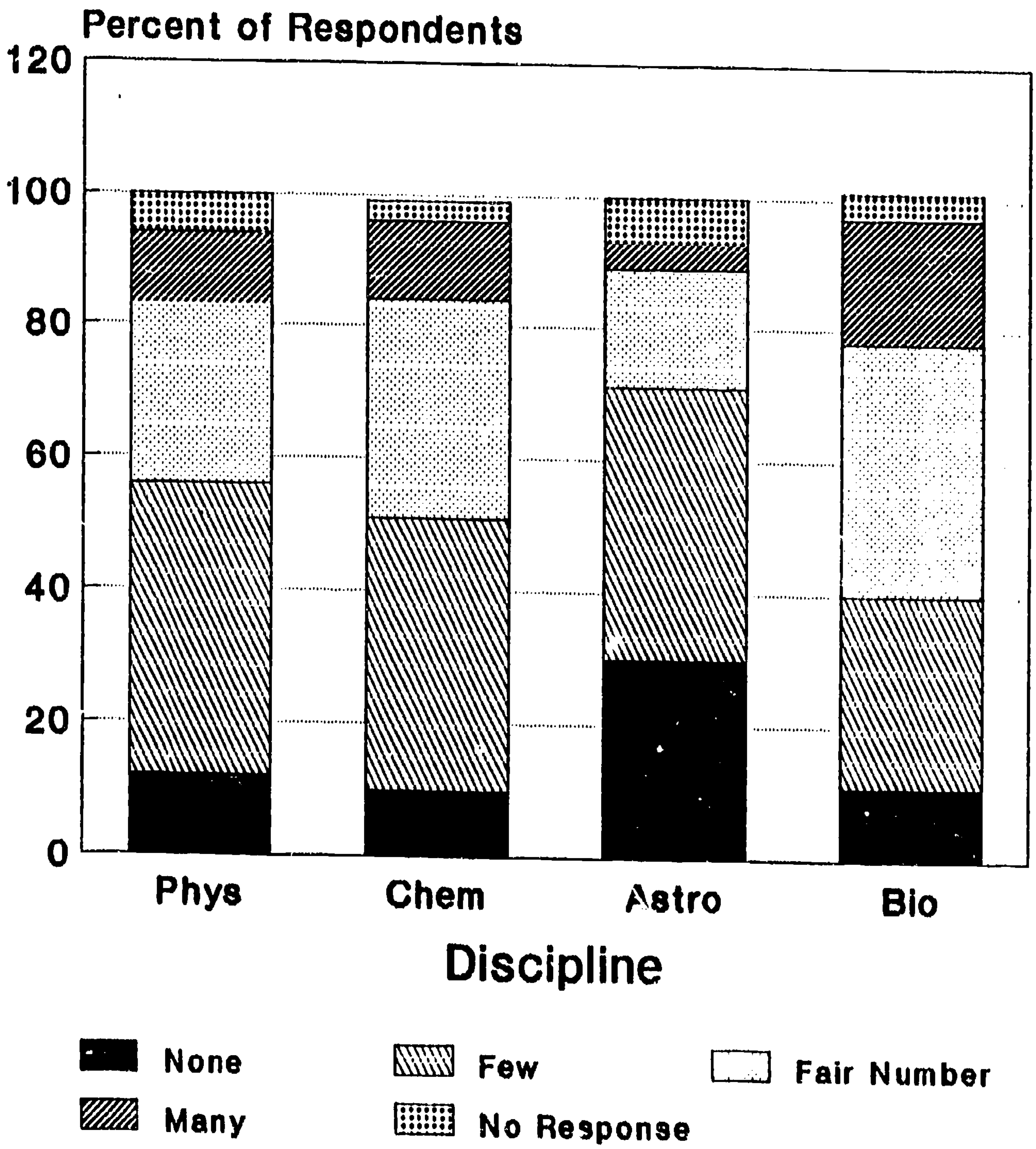
MSST
More Than 20% of Time Spent on Subject



558 Respondents, 6 June 1988

Figure 6

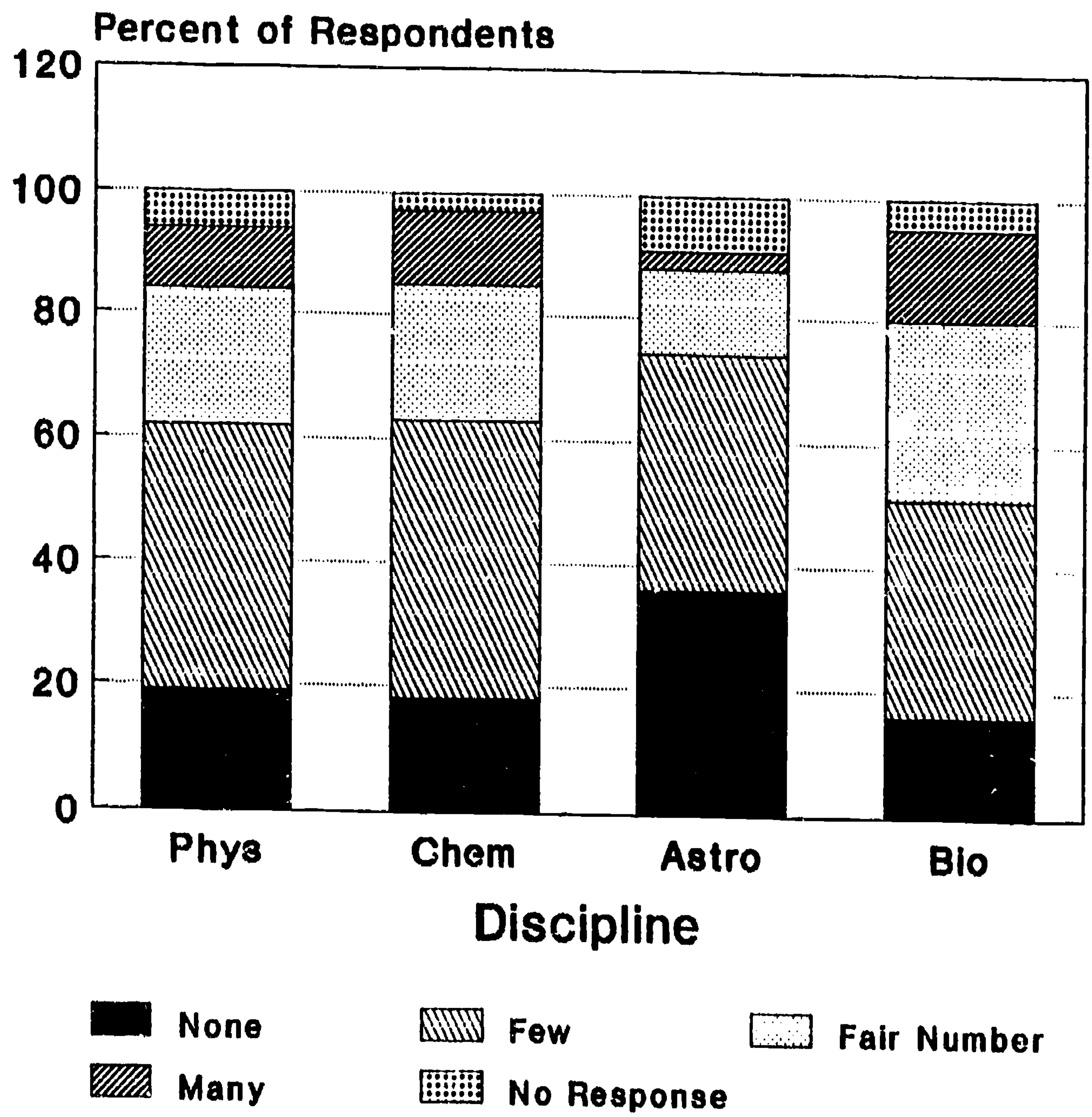
MSST IN NC
Class Demonstrations



558 Respondents, 6 June 1988

Figure 7

MSST in NC
Student Experiments in Class



558 Respondents, 6 June 1988

Figure 8

MSST in NC
Equipment in School
(Cumulative)

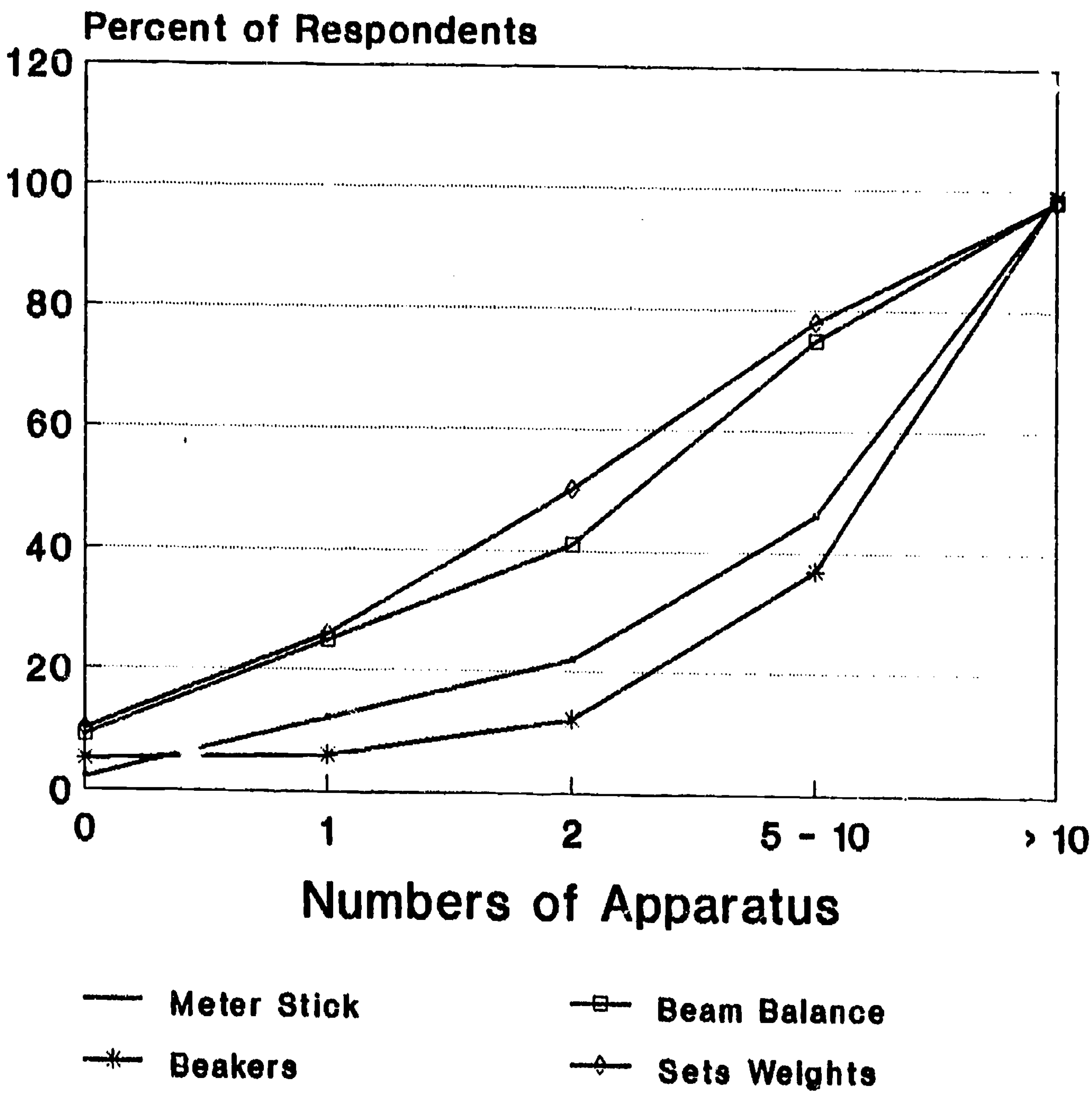


Figure 9

558 Respondents, 6 June 1988

MSST in NC
Equipment in Classroom (Cumulative)

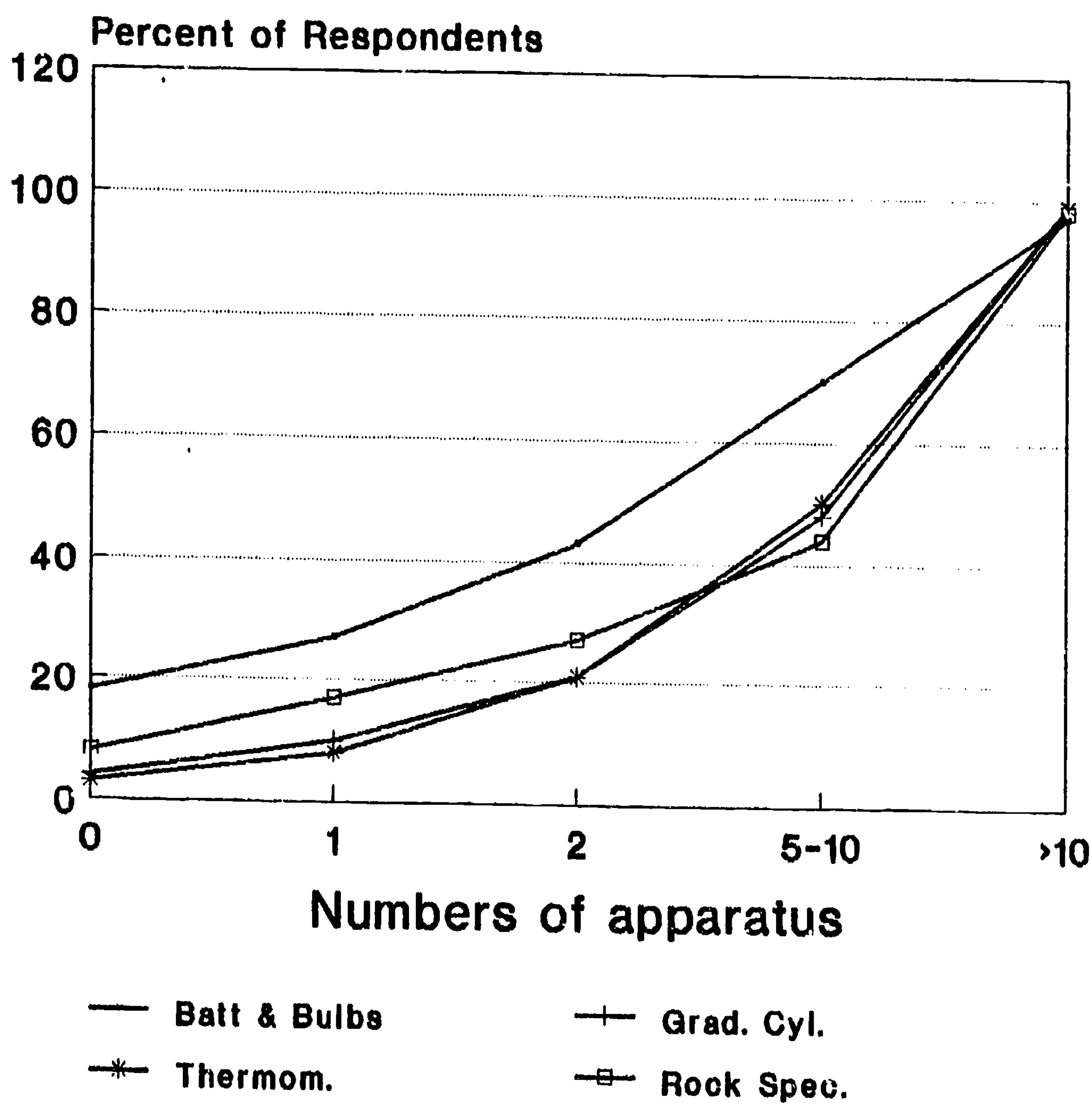
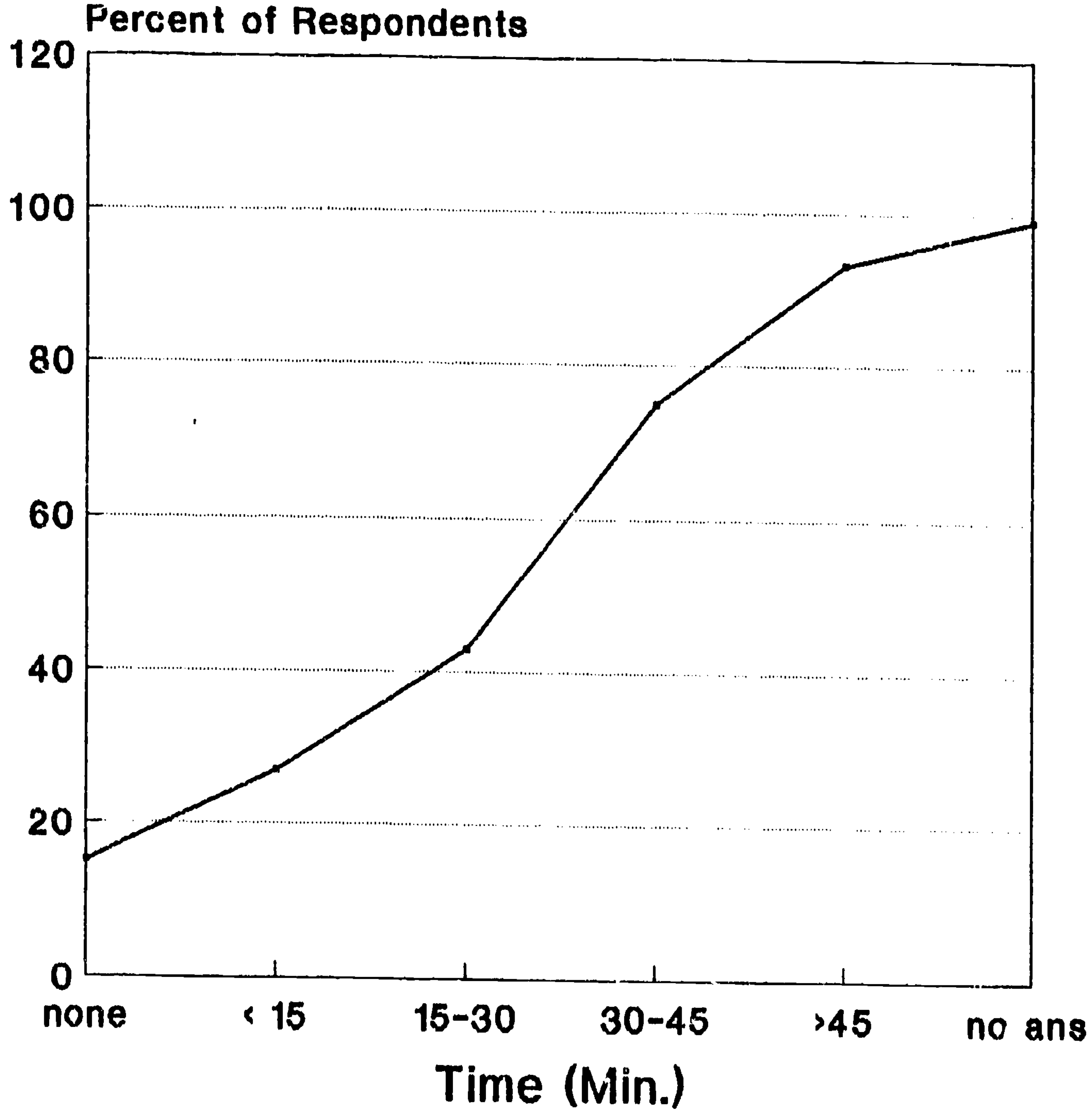


Figure 10

558 Respondents, 6 June 1988

MSST in NC
Demo and Exp Set-up Time (Cumulative)



558 Respondents, 6 June 1988

Figure 11

UNDERGRADUATE MAJOR
Male Middle School Principals

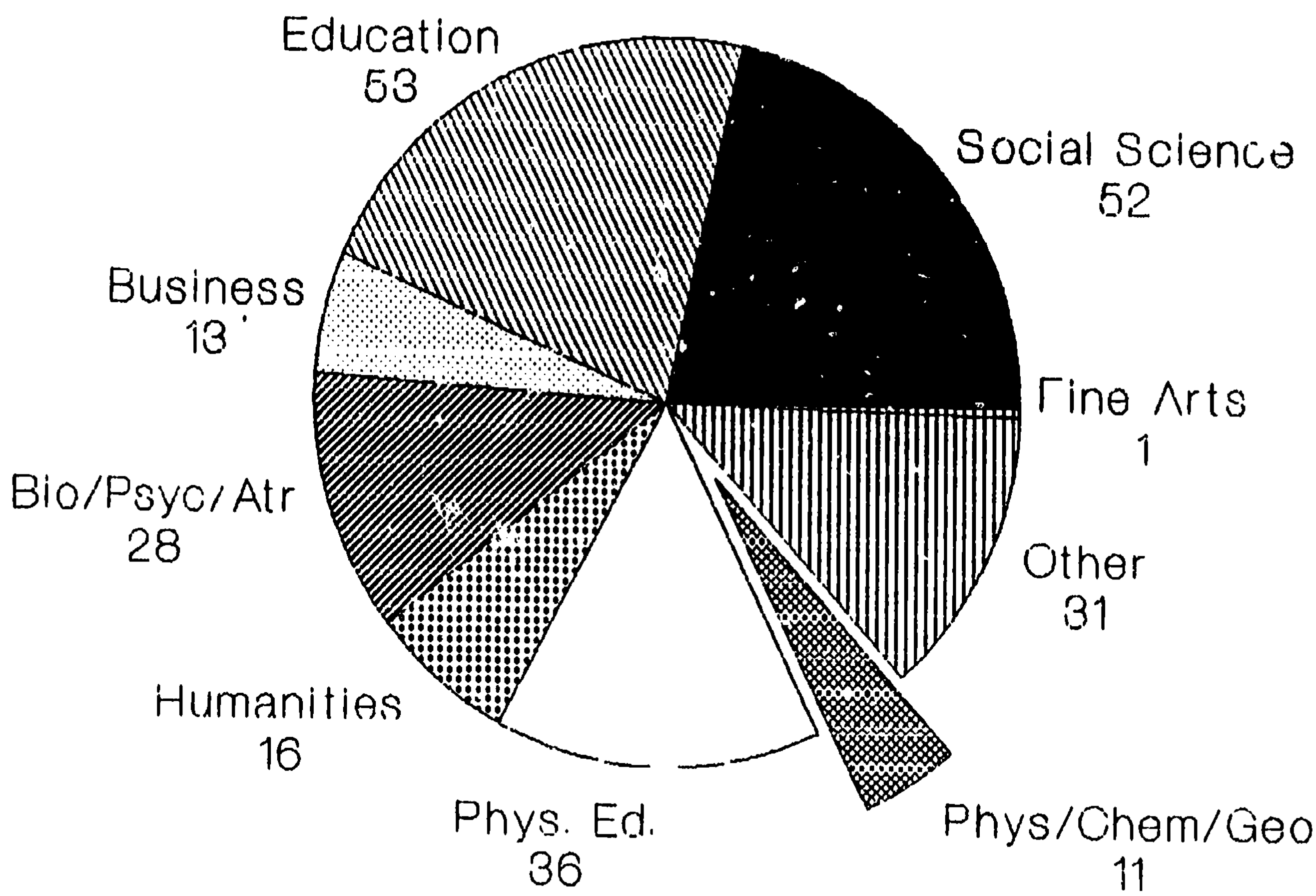


Figure 12

245 Respondents Out of 500

UNDERGRADUATE MAJOR
Female Middle School Principals

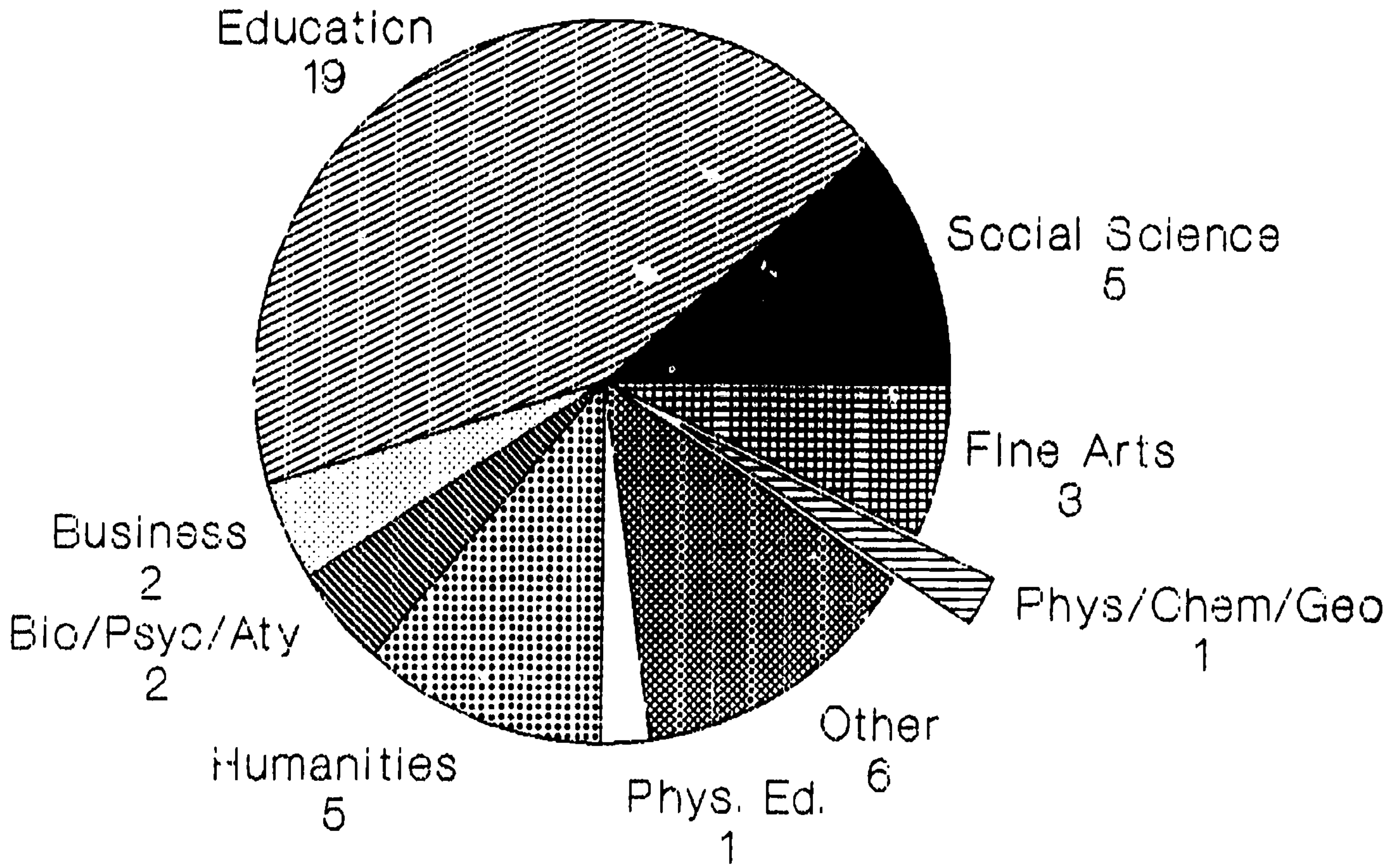


Figure 13

45 of 85 Respondents

MALE MIDDLE SCHOOL PRINCIPALS UNDERGRADUATE SCIENCE COURSE

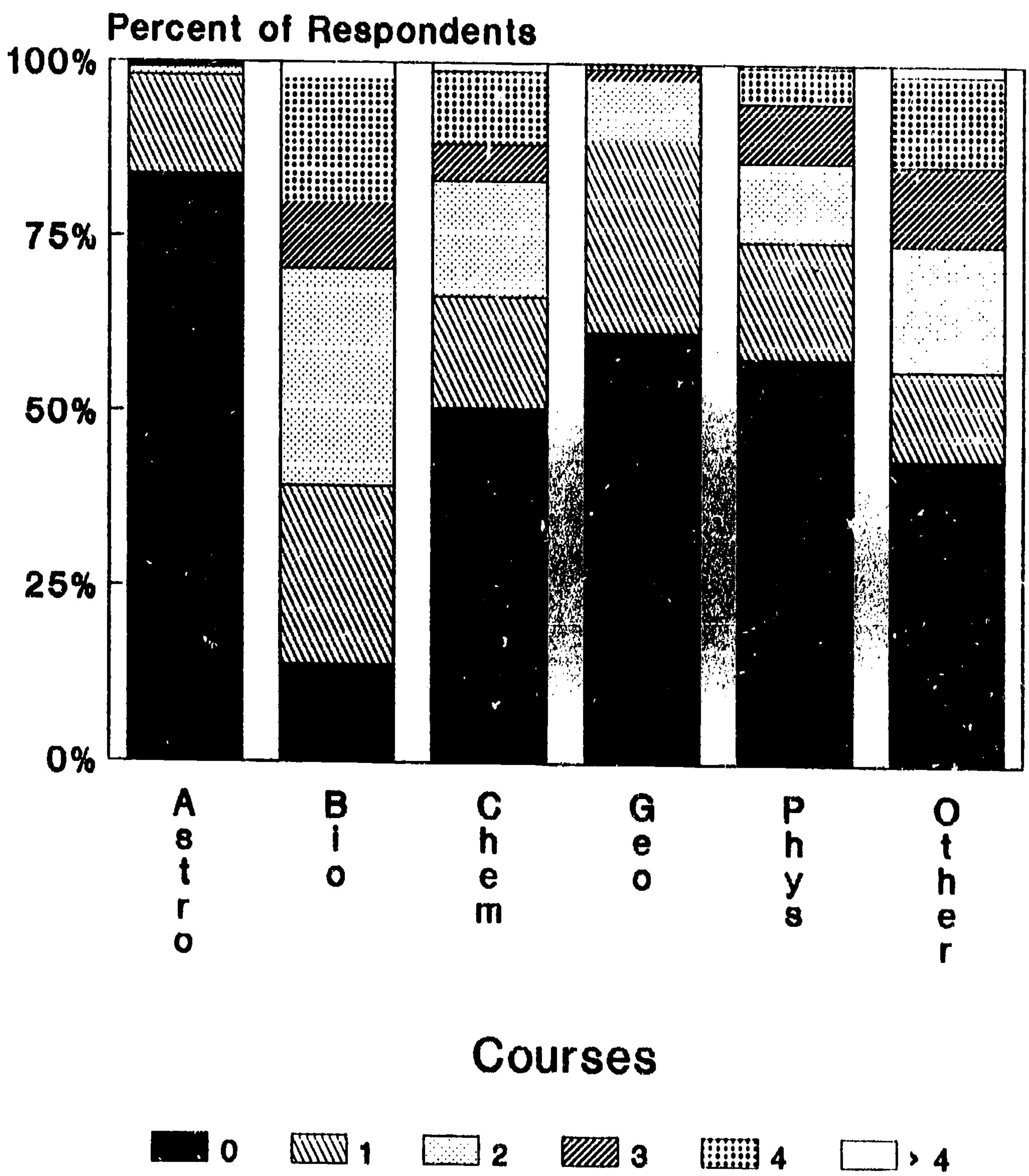


Figure 14

245 Respondents. May 1988

FEMALE MIDDLE SCHOOL PRINCIPAL UNDERGRADUATE SCIENCE COURSE

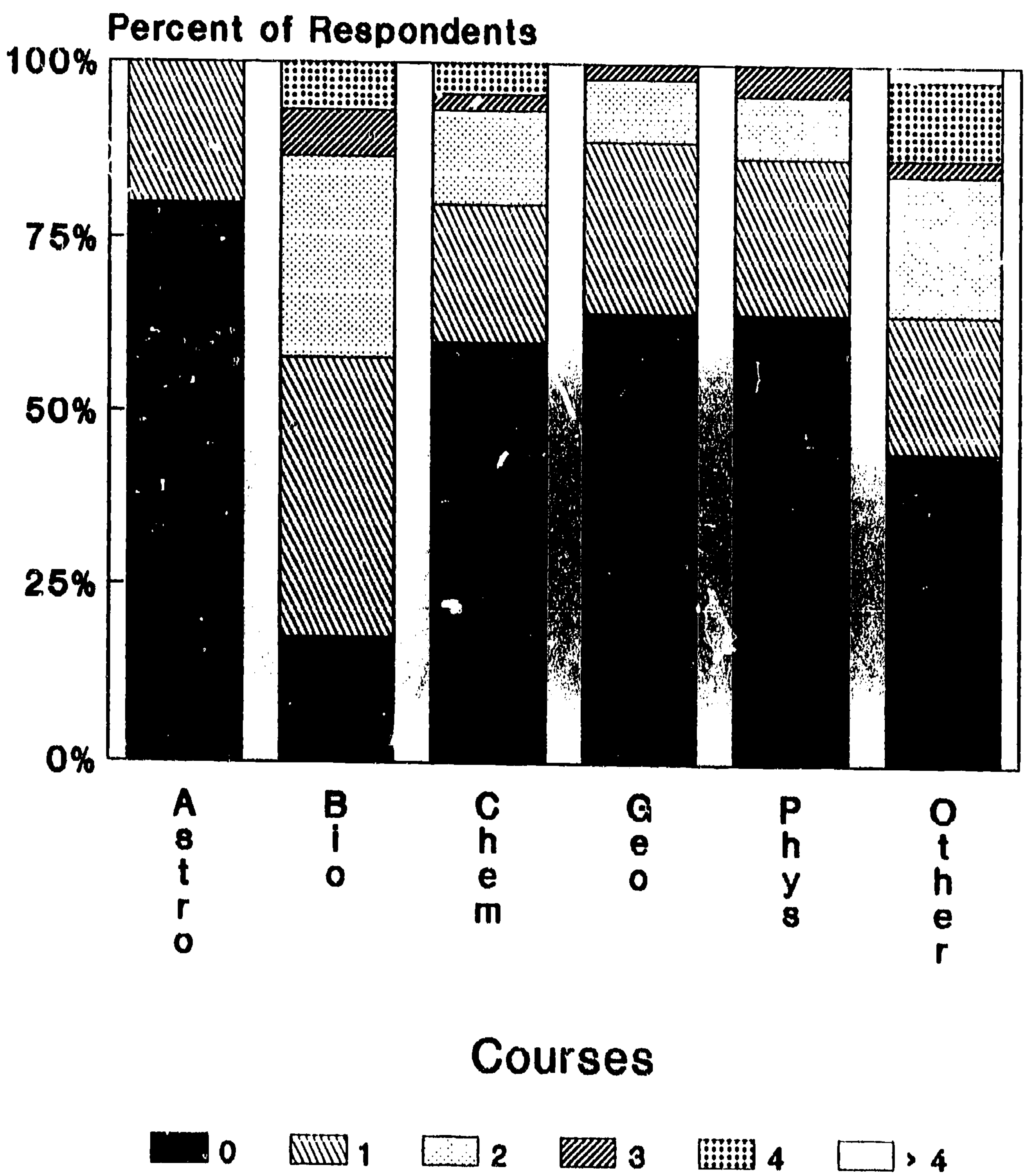


Figure 15

45 Respondents, May 1988

MIDDLE SCHOOL PRINCIPAL PROFESSIONAL BACKGROUND MORE THAN 4 YEARS

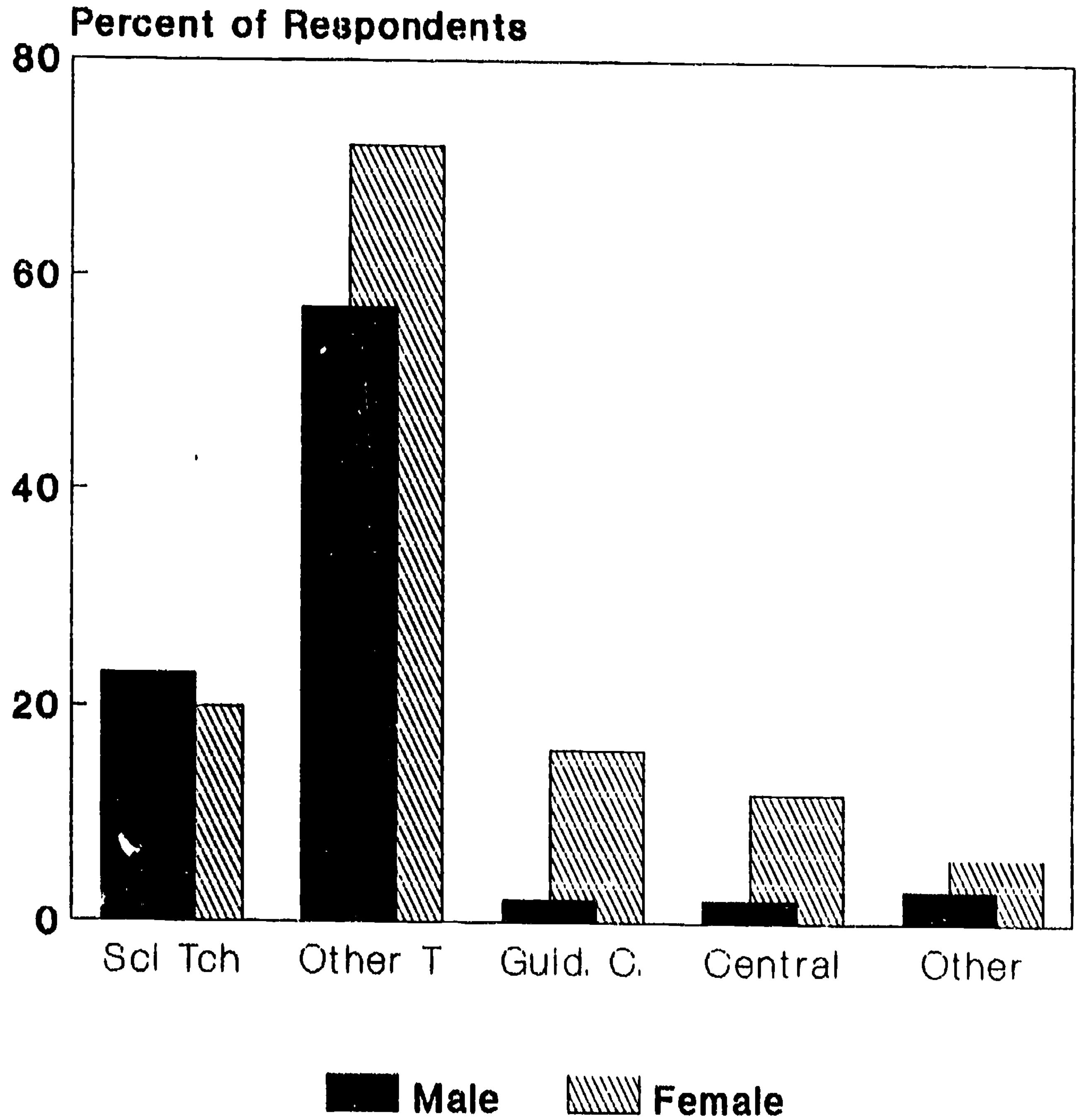


Figure 16

290 Respondents, May 1988

MIDDLE SCHOOL PRINCIPALS RECENT SCIENCE EXPOSURE (MALES)

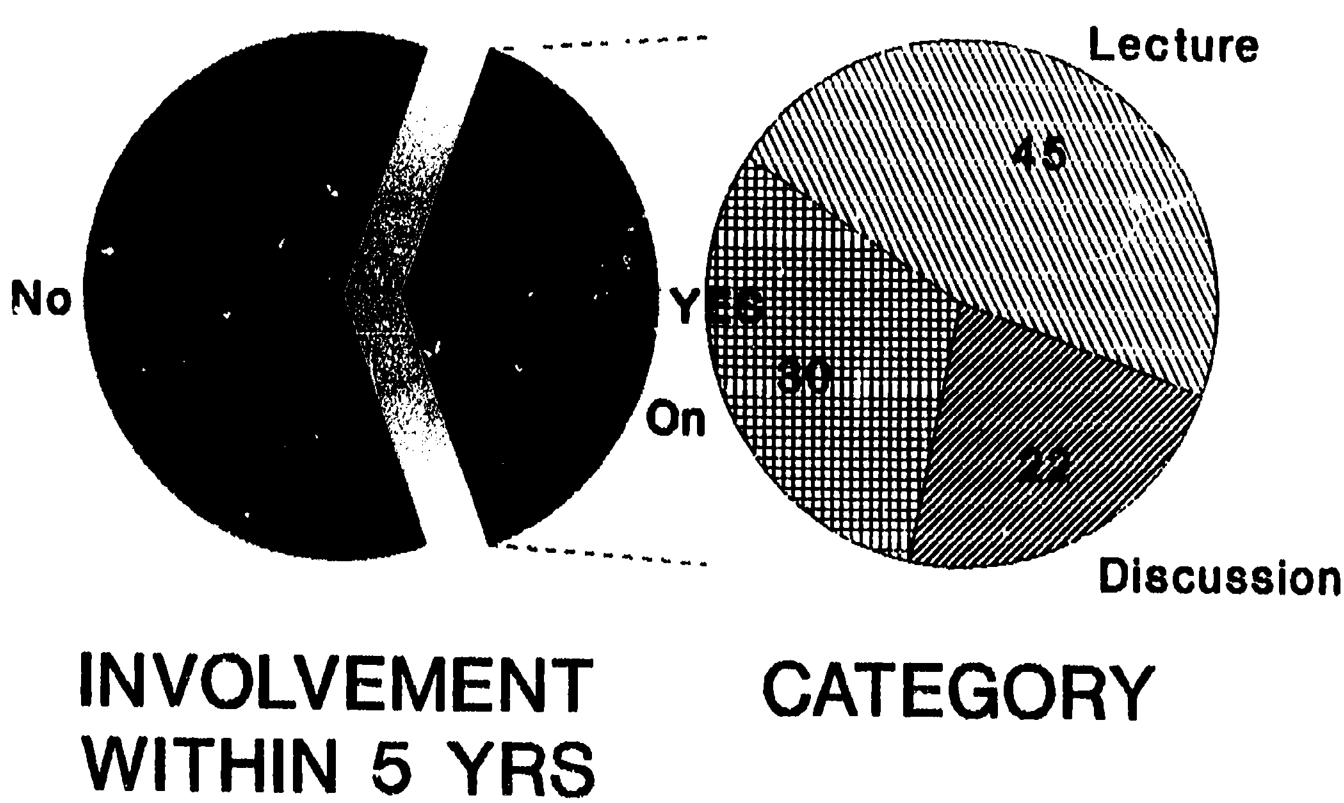


Figure 17

249 Respondents, May 1988

MIDDLE SCHOOL PRINCIPALS RECENT SCIENCE EXPOSURE (FEMALES)

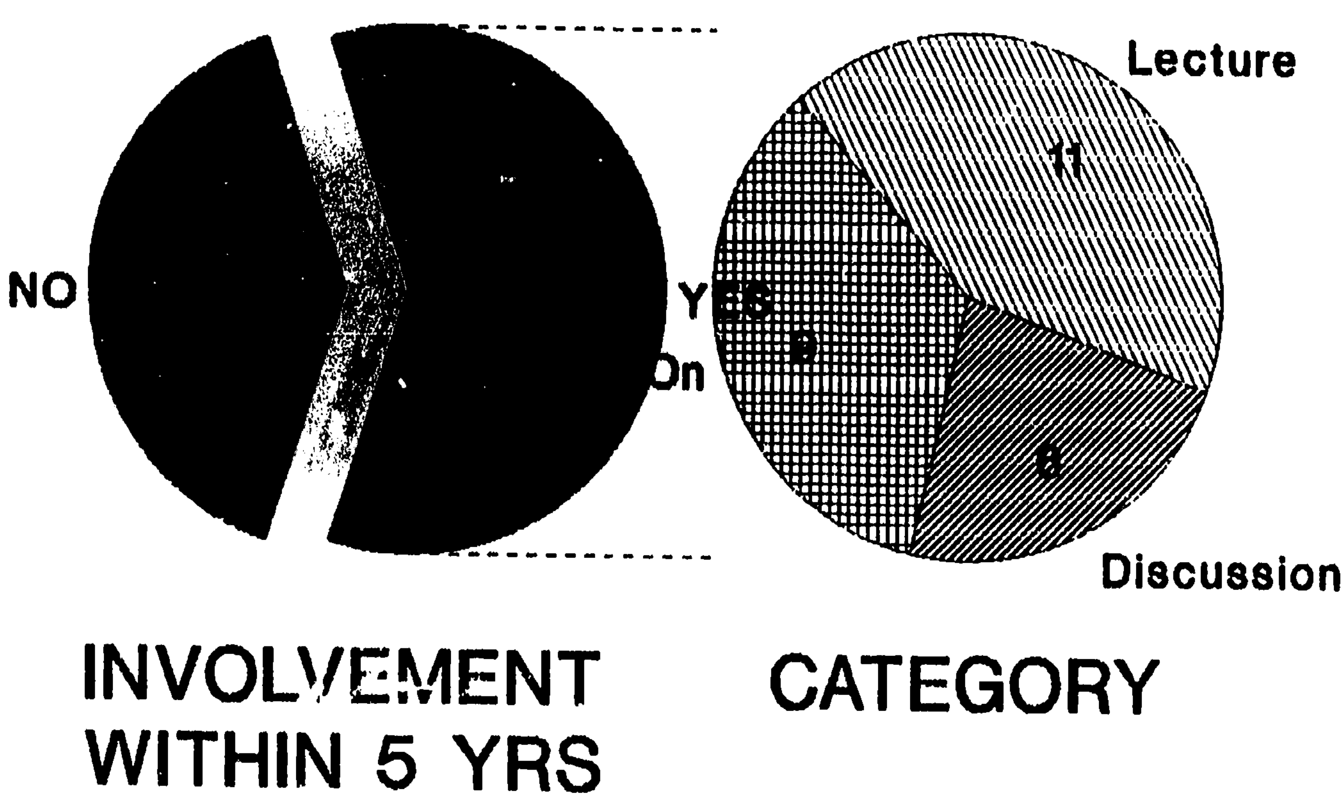


Figure 18

45 Respondents, May 1988

MIDDLE SCHOOL PRINCIPALS FUTURE SCIENCE WORKSHOP

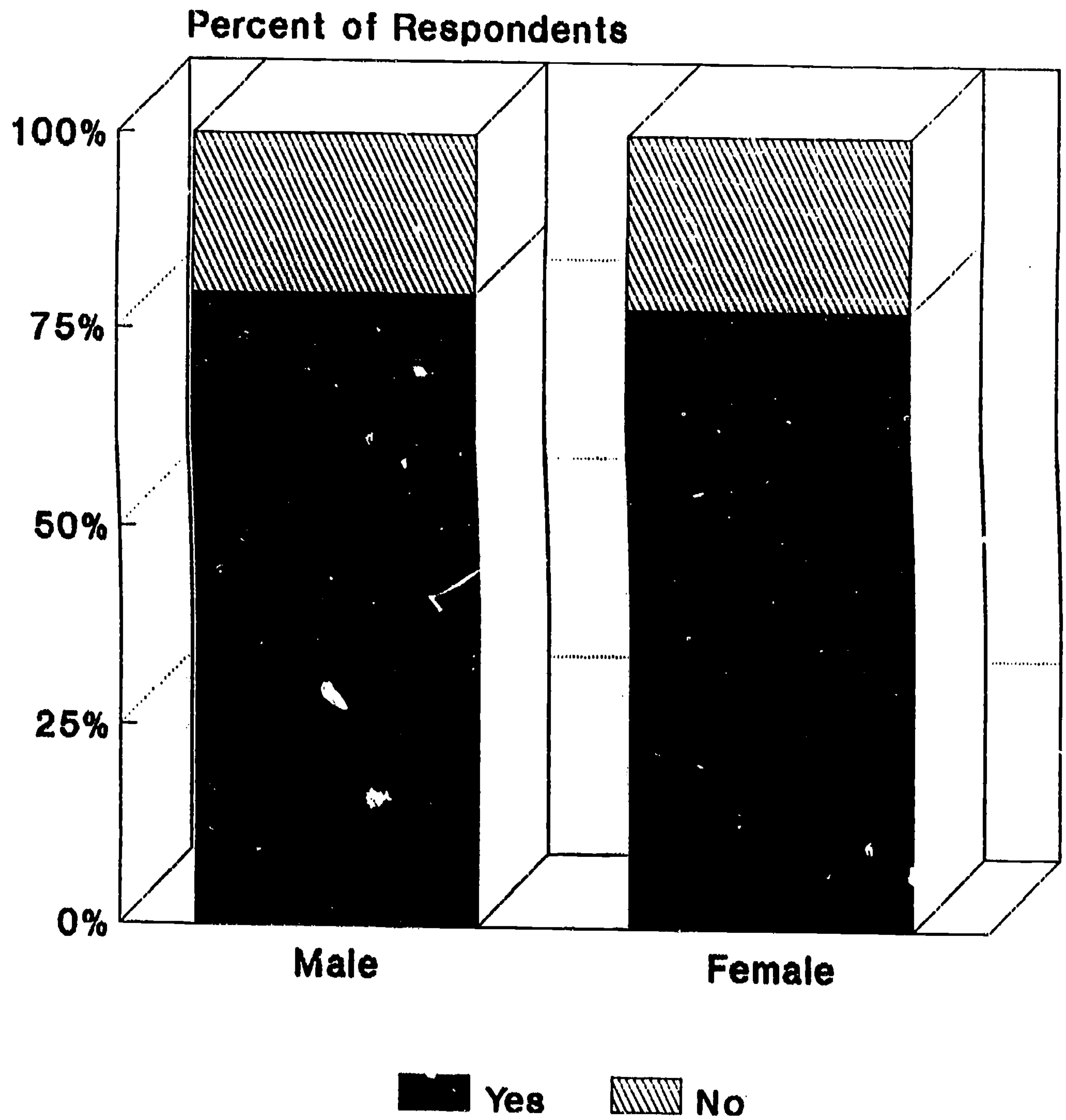


Figure 19

307 Respondents, May 1988
"Would you attend workshop to increase understanding of science?"

MIDDLE SCHOOL PRINCIPALS
TIME LIMITATIONS FOR SCIENCE LEARNING

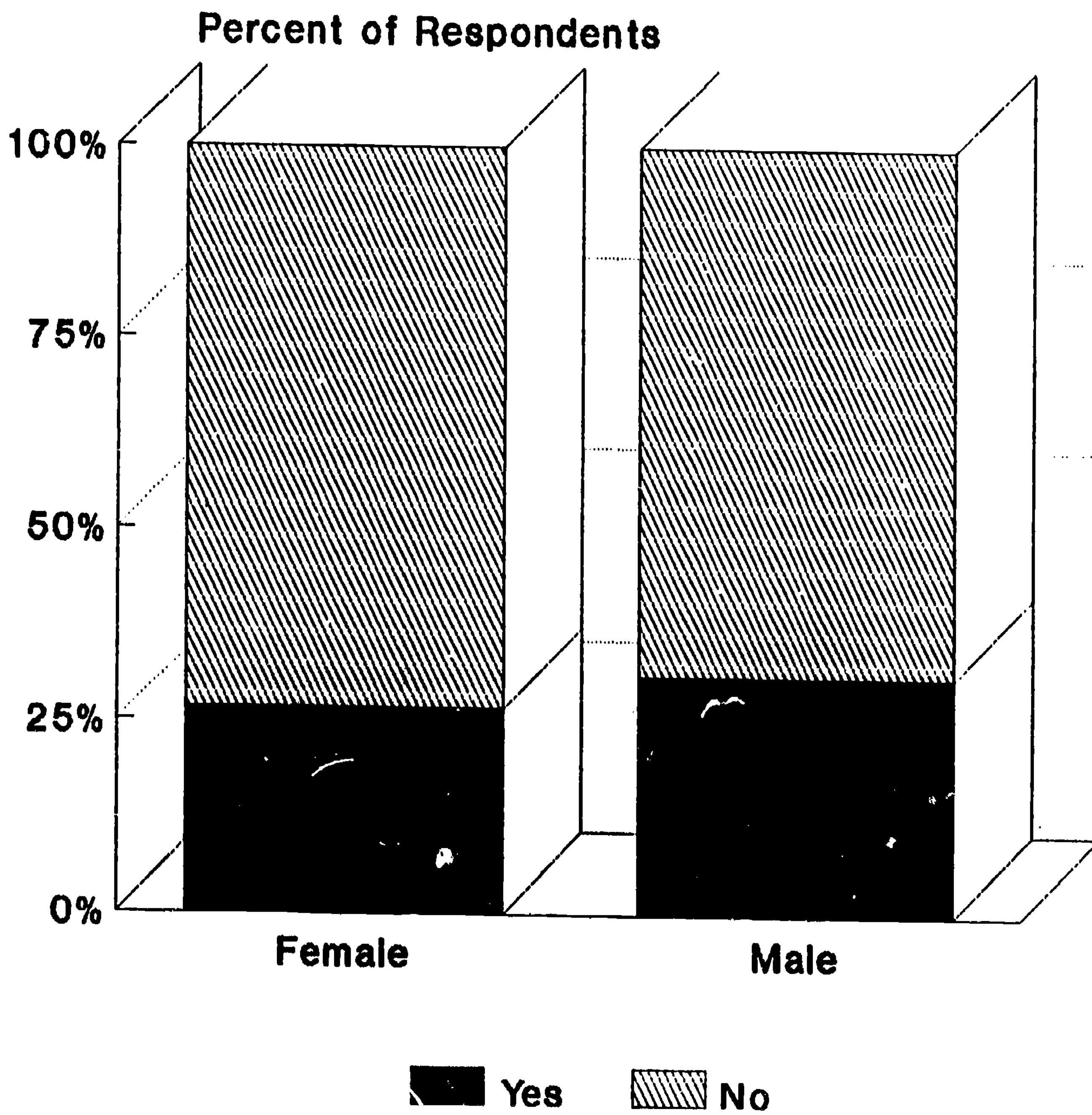


Figure 20

307 Respondents, May 1988
Are you interested in learning science but prevented by time?